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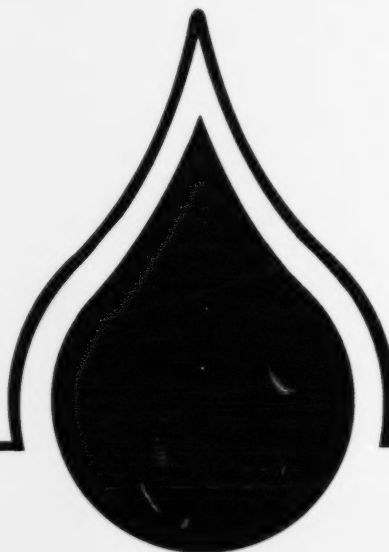
ANNUAL REPORT

MARCH 31
1982



Alberta

OIL SANDS TECHNOLOGY
AND RESEARCH AUTHORITY



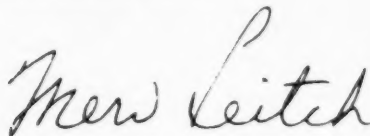


TO HIS HONOUR
FRANK LYNCH-STAUTON
LIEUTENANT GOVERNOR OF THE PROVINCE OF ALBERTA

Sir,

I have the honour to submit the Annual Report of the ALBERTA OIL
SANDS TECHNOLOGY AND RESEARCH AUTHORITY for the fiscal year ended
March 31, 1982.

Respectfully submitted,

A handwritten signature in cursive script that reads "Merv Leitch". The signature is written in dark ink and is positioned above the printed name and title.

MERV LEITCH
Minister of Energy and Natural Resources



Seventh
ANNUAL REPORT
March 31,
1982

Alberta

OIL SANDS TECHNOLOGY
AND RESEARCH AUTHORITY



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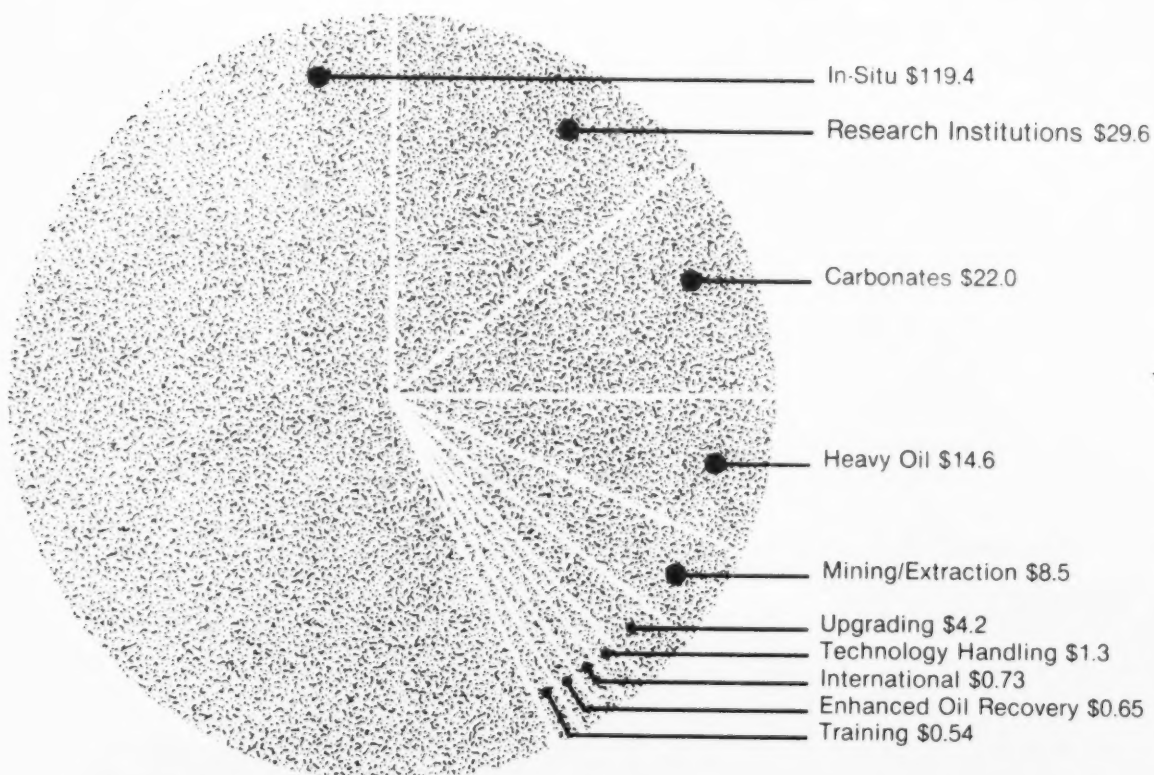
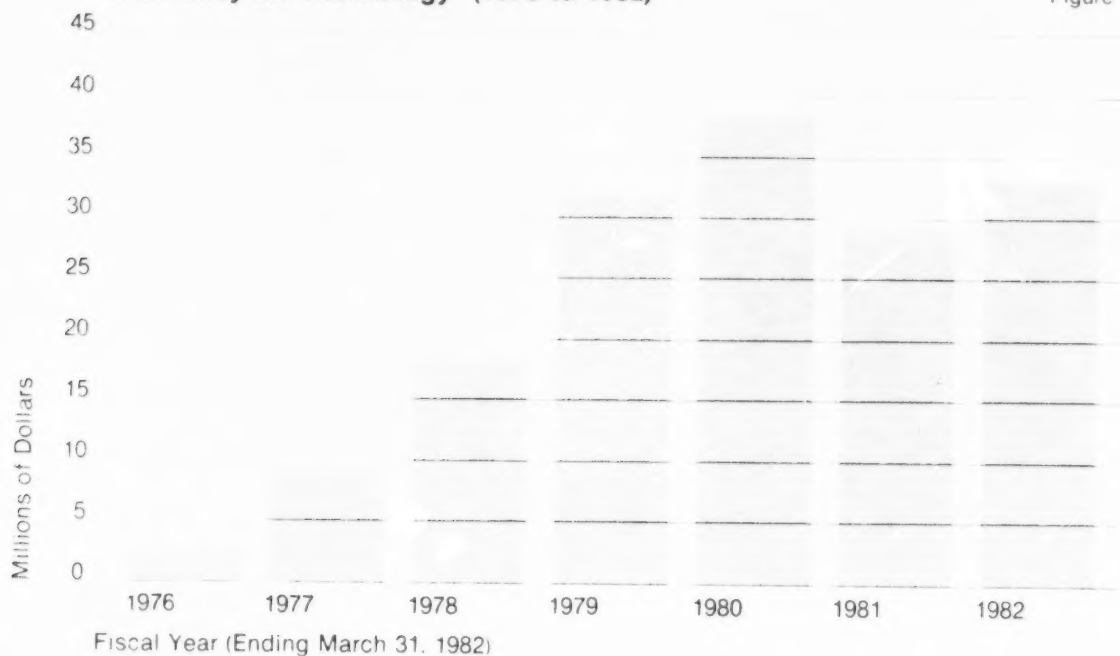


FOREWORD

On January 14, 1974, the Premier of Alberta announced the availability of \$100 million to develop new technology for the recovery and processing of petroleum from the Alberta Oil Sands. The terms and conditions for the disbursement of these funds are described in The Oil Sands Technology and Research Authority Act, passed by the Legislature in June 1974 and since amended to include the recovery of heavy oils and the enhanced recovery from conventional petroleum reservoirs. An additional \$318 million has been dedicated by the Alberta Cabinet to permit the funding of longer term programs extending beyond 1985.

Annual Investment by AOSTRA in Oil Sands and Heavy Oil Technology (1976 to 1982)

Figure 1



Commitments from AOSTRA Research Fund
to March 31, 1982 (\$Millions)

Figure 2

SEVENTH ANNUAL REPORT of the ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY

To the Honourable Merv Leitch
Minister of Energy and Natural Resources

Sir,

I have the honour to present the Seventh Annual Report of the Alberta Oil Sands Technology and Research Authority for the year ended March 31, 1982.

A major feature of AOSTRA's technology plan has been the establishment of a series of strategic pilot tests in each of the major oil sands and heavy oil reservoirs. Highlights for each project are given below.

Peace River Deposit

- The AOSTRA Shell Canada Resources Limited Project has completed its second year of operation, and is now entering the critical depressurization phase, which will give a good indication of the commercial viability of the process.

Athabasca Deposit

- The AOSTRA Amoco Canada Petroleum Company Ltd. combustion pilot was unsuccessful in establishing communication among the operating wells. New projects are being planned for the Athabasca deposit designed to overcome this problem.
- AOSTRA and Gulf Canada Resources Inc. have completed an economic assessment of horizontal wells, and AOSTRA is presently looking for private-sector participants to test the concept in the field.
- The Retco process continues to show considerable promise as a method of reducing the size of the tailings ponds associated with the Hot Water Process. A continuous flow pilot plant has been constructed and will shortly be tested at the Syncrude plant.
- The UMATAC Dry Retorting pilot plant is nearing the end of its test program in Calgary. Two industrial participants have joined AOSTRA in the program. Plans for a large scale demonstration plant are being prepared.
- An Oil Sands Demonstration Centre proposal has been put together by AOSTRA and nine other organizations. The basis for a joint venture agreement for this facility is currently being discussed.

Carbonate Deposit

- The AOSTRA Union Oil Company of Canada Limited steam pilot showed good performance during 1981. A larger 5-spt pilot is currently being constructed.

Cold Lake Deposit

- The AOSTRA BP Exploration Canada Limited pilot has completed its third year of operation and conversion to the key combustion drive stage will take place in 1983. Production rates are less than targeted, but still believed to be commercial by the operator.

Enhanced Recovery of Conventional and Heavy Oils

- The combustion pattern of the AOSTRA Petro-Canada Exploration Inc. pilot southwest of Lloydminster is continuing. It is still too early to assess results.
- Construction of the AOSTRA Alberta Energy Company pilot in the Suffield Block was completed during 1981 and combustion commenced in February, 1982.

- Our conventional light oil program has been very difficult to initiate, due in part to the complexity of carrying out experimental studies on producing reservoirs. AOSTRA is reviewing several interesting proposals and formulating principles for joint participation. It is expected that several of these projects will be funded in the coming year.

Heavy Oil Upgrading

- AOSTRA and twelve other organizations are well along in assessing nine new upgrading processes, and plan to reach a decision on the construction of a demonstration plant during 1983.

Other general AOSTRA activities include:

- Two new AOSTRA professorships were awarded, one on the chemistry of bitumen to Dr. O.P. Strausz at the University of Alberta, and one on the desulphurization of coke to Dr. E.L. Tollefson at the University of Calgary.
- An agreement with the Alberta Research Council on a jointly-funded 5-year program on oil sands research was concluded and a method by which industry can get early access to the results is being formulated.
- The interest in acquiring the technology from AOSTRA-funded projects by industry continued at a high level and seminars, conferences, courses and workshops sponsored by AOSTRA during the year were well attended.
- In the international area AOSTRA expertise and advice continued to be sought and assistance such as training of engineers and scientists was well received. AOSTRA personnel carried out working assignments in Venezuela and Brazil and engineers from Argentina, Brazil and Venezuela came to Alberta.
- AOSTRA co-sponsored the very successful 2nd UNITAR Conference held in Caracas, February 7-17, and agreed to provide the information bank necessary to start the International Heavy Oil and Tar Sand Information Centre in New York.
- A major new initiative was the launching of a study of commercial processes available for recycling co-produced water in enhanced oil recovery and in situ oil sands projects. AOSTRA is the project manager of the first phase of a wide-ranging search for new and more economical methods of water treatment.

AOSTRA continues to receive one application per week for the funding of new projects. The fact that after 7 years the application rate shows no signs of diminishing indicates that there is no shortage of ideas for increasing the recovery and utilization of our petroleum resources.

Perspective:

AOSTRA believes that the search for technology to commercialize the oil sands must continue at a steady pace. Research and development should not be abandoned because of a short-term perception of a low economic return on investment. History has shown that industry responds to short-term economic cycles in predictable ways. When the economic climate is rosy, optimism is high and fast results are expected. There is insufficient time, however, to develop innovative technology. When economic conditions are less favorable, research is reduced or terminated and experienced workers are moved to short-term, high-yield activities, or laid off. Both these situations are inimical to good solid advances in technology and should be avoided.

The question is, with reduced cash flow, can industry maintain its previous level of R & D activity? AOSTRA's answer is yes, if industry is willing to work cooperatively in joint projects and to share the cost. We intend to present this case vigorously to industry in the coming year.

Respectfully submitted,

C. W. Bowman

C.W. Bowman, P.Eng.
Chairman

MEMBERS OF THE AUTHORITY

CHAIRMAN

Dr. C W. Bowman

VICE-CHAIRMAN

Mr. M.A. Carrigy

MEMBERS

Dr. H.E. Gunning

Mr. J.A. Harvie

Mr. F.A. Kidd

Mr. M.G. Pahl

Dr. E.J. Wiggins

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STAFF

EXECUTIVE OFFICE

Edmonton

Dr. C.W. Bowman, P. Eng., Chief Executive Officer
Mr. M.A. Carrigy, P. Geol., Chief Administrative Officer
Mrs. B.J. Stonier, Executive Assistant to Chairman

TECHNICAL

Edmonton

Mr. L.R. Turner, P. Eng., Director, Mining, Extraction & Upgrading
Mr. F.J. Werth, Manager, Mining & Extraction Processes
Mr. R.T. Bailey, P.Eng. Senior Project Engineer – Upgrading
Mrs. K.J. Cochrane, Project Engineer
Dr. T.J. Cyr, Manager, Technical Programs
Mr. R.R. Germain, Project Engineer – Upgrading
Dr. C. Hsi, P.Eng. Senior Project Engineer
Mr. A.C. Thakrar, Project Specialist

Calgary

Mr. R.S. Phillips, P. Eng., Director, In Situ Operations
Dr. R.W. Lunning, P. Eng., Manager, Thermal Projects
Mr. M.S. Carleton, CDP, Data Base Administrator
Mr. R.T. Curry, Systems Analyst
Dr. T.S. Lee, Project Engineer

ADMINISTRATIVE

Edmonton

Mr. W.G. Kowaluk, C.A., Manager, Finance, Personnel & Administration
Miss E.K. Spady, LL.B, General Counsel
Mr. G.A. Villett, Registrar
Mrs. L.G. Benzer, Information & Records Officer
Mr. L.J. Miskiw, Administrative Accountant
Mrs. S.A. Reimond, Secretary
Miss B.J. Storey, Secretary
Miss D.M. Shulak, Records Co-ordinator
Miss D.L. Borhen, Receptionist

Calgary

Mrs. M.H. Wagner, Secretary

Ms. V.M. Foster, Receptionist

CONSULTANTS

PROJECT TECHNICAL REPRESENTATIVES

Mr. B.H. Sherwood, (UMATAC)

Mr. H.T. Gennings (BP)

Mr. K.R. Ronaghan, (AEC)

Mr. G. Van der Voet (Union)

Mr. G.E. Andrews (Shell)

TECHNICAL ADVISORS TO STAFF

Mr. J.H. Nicholls, Director, Technical Programs

Dr. L.G. Hepler, Manager, University Research

Mr. J.D. Scott, Manager, Enhanced Recovery

Mr. G.M. Cordell, Senior Reservoir Engineer

Mr. J. Chrones, Heavy Oil Study

Dr. S.M. Creighton, Advisor, Patent Committee

Mr. H.G. Stephenson, Mining

Mr. P.H. Holst, Mathematical Modelling

Mr. W. Vandenhengel, UMATAC Technical Committee

Mr. R.D. Humphreys, UMATAC Management Committee

Mr. M.R. Farries, Oil Sands Demonstration Centre

Mr. R.W. Craig, Oil Sands Demonstration Centre

Mr. T.F. Harkness, Produced Water Treatment Study

Mrs. S.E. Green, Technology Librarian

LEGAL

Miss H.S. Tymoczko, LL.B.

Mr. E.P. Johnson, (Patents & Technology Agreements)

Field and Field (Project Agreements)

PROJECT AUDITORS

Touche Ross & Co.

PUBLIC RELATIONS

Berger, Hetherington & Associates

MEMBERS OF APPRAISAL PANELS

UNIVERSITY OIL SANDS RESEARCH EVALUATION PANEL

Dr. D.W. Bennion, University of Calgary
Dr. R.M. Butler, Esso Resources Canada Limited
Dr. L.G. Hepler, (Chairman), University of Lethbridge
Dr. H.R. Krouse, University of Calgary
Dr. A. Logan, Gulf Canada Resources Inc.
Dr. D.S. Montgomery, University of Alberta
Dr. N.R. Morgenstern, University of Alberta
Mr. R.H. Roda, Husky Oil Operations Inc.

SCHOLARSHIP AND FELLOWSHIP SELECTION COMMITTEE

Dr. S.B. Woods (Chairman), University of Alberta
Dr. F.D. Otto, University of Alberta
Dr. G. Berg, University of Calgary
Dr. J.B. Hyne, University of Calgary
Dr. K.G. McCurdy, University of Lethbridge
Dr. E.J. Wiggins, Alberta Oil Sands Technology and Research Authority
Dr. H.E. Gunning, Alberta Oil Sands Technology and Research Authority

PATENT COMMITTEE

Dr. T.J. Cyr, (Chairman), Alberta Oil Sands Technology and Research Authority
Miss E.K. Spady, Alberta Oil Sands Technology and Research Authority
Mr. J.H. Nicholls, Alberta Oil Sands Technology and Research Authority
Mr. L.R. Turner, Alberta Oil Sands Technology and Research Authority
Mr. M.A. Carrigy, Alberta Oil Sands Technology and Research Authority
Dr. L.G. Hepler, University of Lethbridge
Dr. R.W. Lunning, Alberta Oil Sands Technology and Research Authority

MICROBIOLOGY EVALUATION PANEL

Dr. F.D. Cook, (Chairman), University of Alberta
Dr. T. Kaneda, Alberta Research Council
Dr. A.M. Jobson, Alberta Research Council

REPORT OF ACTIVITIES

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Edmonton, Alberta T5J 3L8, Telephone (403) 427-7623 Telex 037-3519

Applications for Funding

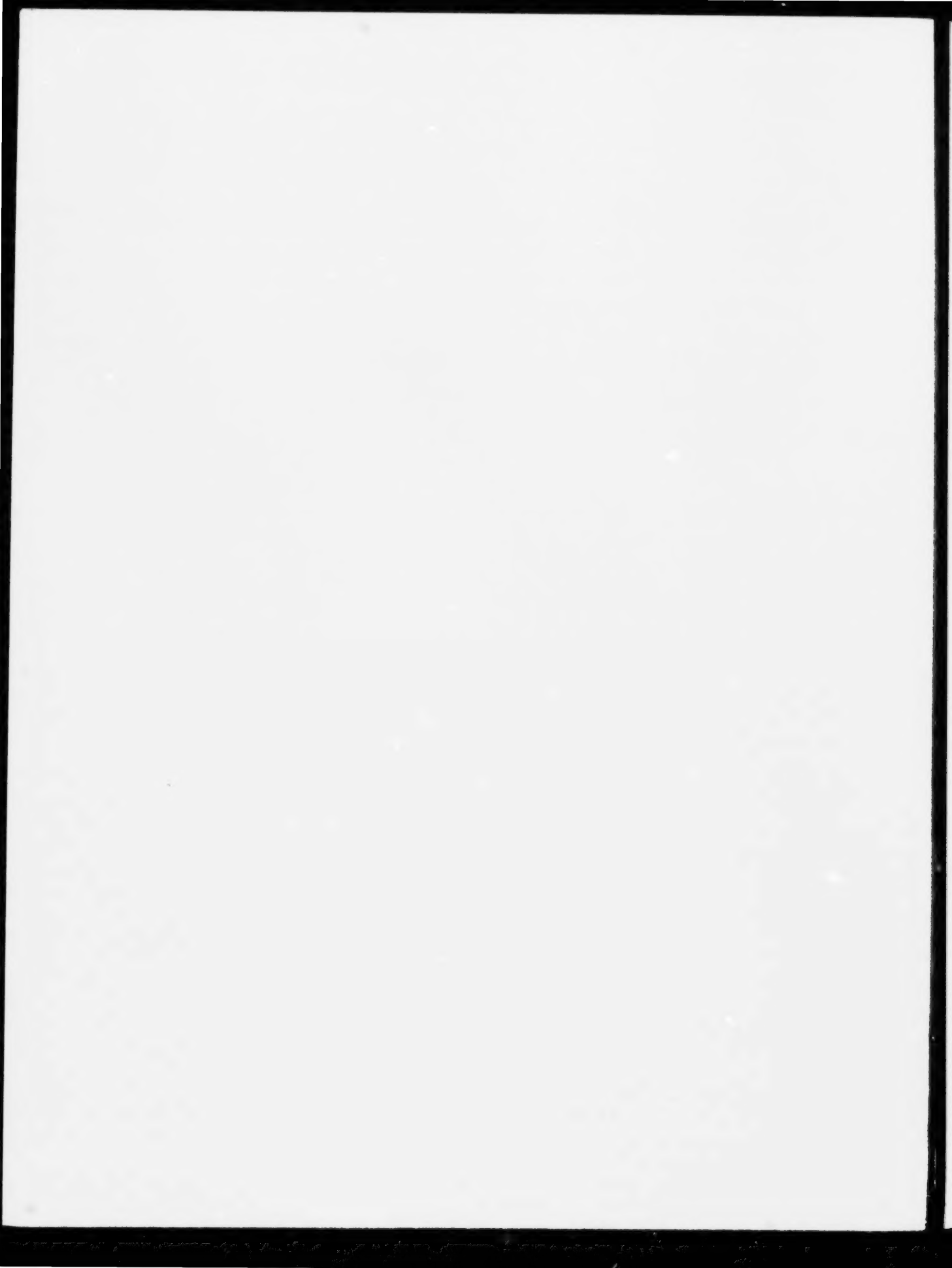
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Mrs. H. Radvanyi, 6th Floor, Highfield Place, 10010 - 106 Street,
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REPORT OF ACTIVITIES

1. IN SITU OIL SANDS RECOVERY PROGRAM

1.1 AOSTRA - AMOCO Gregoire Lake Pilot Project

This joint project of AOSTRA and Amoco Canada Petroleum Company Limited is located near Gregoire Lake in the Athabasca oil sands, about 40 km southeast of Fort McMurray. Other industry participants are Petro-Canada Exploration Inc., Shell Canada Resources Limited and Suncor Inc. The formation being investigated is the lower pay zone of the Lower McMurray Formation, which is some 27 m (90 ft.) thick, at a depth of 330 m (1080 ft.).

The objective of the project was to evaluate a recovery process developed by Amoco called COFCAW (Combination Forward Combustion and Waterflood).

Unique operating features at the pilot site included an extensive automated data gathering system, sophisticated well completions, and a thorough environmental monitoring system.

The target recovery was 50% of the oil-in-place, and peak production was predicted to be 125 m³ d (780 bbl day). The pilot commenced operations in mid-1977 and was terminated as of December 31, 1981. Lack of uniformity in the reservoir caused major difficulties. Little heat communication was established between the central wells of each five-spot and the surrounding production wells. There were also problems with the wells themselves; a number of casing strings were inexplicably damaged, requiring repairs. One hypothesis to explain the damage is that the ground shifted slightly causing the casing strings to bend or shear.

All injection and production wells now have been abandoned. Results of the pilot are being analyzed prior to further tests in the area.

1.2 AOSTRA - BP Marguerite Lake Pilot Project

The AOSTRA-BP Exploration Canada Limited Marguerite Lake Pilot Project is located in the Cold Lake oil sands deposit approximately 45 km (28 miles) north of the town of Bonnyville, Alberta. Other industry participants are Hudson's Bay Oil & Gas Company Limited and PanCanadian Petroleum Limited.

The producing zone is 35 m (115 ft.) thick at a depth of 460 m (1500 ft.) The recovery method being tested is a sequential process of cyclic steam stimulation followed by combustion drive.

The project is now in its third year of steam stimulation and air injection into special test areas has evaluated the initial combustion phase.

It is still too early to determine whether the sequence of steam and combustion will yield better results than the use of steam alone. However, preliminary information from the experimental combustion wells has been encouraging.

Three new producing wells and four new observation wells were drilled in 1981 to test closer well spacing and a modified pattern configuration.

A study on the use of oxygen enriched air for combustion operations was carried out and a new test using oxygen in one well will be carried out in 1982.

1.3 AOSTRA - SHELL Peace River Pilot Project

The AOSTRA-Shell Canada Resources Ltd. Shell Explorer Ltd. Peace River Project, located 30 km (18 miles) northeast of Peace River, is a large pilot in terms of both facilities and engineering effort. It is designed as a prototype installation which hopefully will lead to a commercial-scale operation. Amoco Canada Petroleum Company Limited is also a participant in this project.

At the pilot site the oil sands are at a depth of 550 m (1815 ft.) and are 27 m (90 ft.) thick. The oil sands deposit under the Shell lease has a 3 m (10 ft.) bottom interval of high water saturation, which has provided an initial path for steam movement at the base of the reservoir.

The test is evaluating cyclic pressurization of the reservoir using steam. This process was extensively investigated by physical and mathematical simulation tests prior to the field tests.

Construction was completed and the operating phase commenced in the fall of 1979. Construction cost was approximately \$70 million and annual operating costs are in the order of \$15 million.

The minimum time required to collect definitive pilot performance data is expected to be about 5 years.

Steam stimulation and the first pressurization cycle of the producing wells has been completed and the first blow down phase has recently commenced. The coming year will provide key performance data from the pilot.

1.4 AOSTRA – UNION Buffalo Creek Pilot Project

The very large reserve of bitumen in the Devonian carbonate formations of northern Alberta warrant a major field and laboratory research effort. AOSTRA and Union Oil Company of Canada Limited are conducting field tests at the Buffalo Creek site, which is located above the Grosmont subcrop approximately 100 km (62 miles) west of Fort McMurray. Canadian Superior Oil Ltd. is also a participant in this project.

The project has been underway since 1977, evaluating steam stimulation (huff and puff), steam drive, and partially-quenched forward combustion. In 1978, the pattern was turned into an inverted 5-spot, and two additional wells were drilled in 1979. Operation of these wells was discontinued in 1981.

During 1980-81 a one-well steam stimulation pilot was operated through six cycles. Results have been encouraging and an expanded steam pilot is being constructed. This new pilot, located about two miles southeast of the original pilot site, consists of a single five spot steam stimulation test.

Drilling is complete and operations are scheduled to commence in mid 1982.

The new test, if successful, could lead to rapid commercial development in the area.

1.5 AOSTRA – GULF Horizontal Drilling Pilot

This project, which has the objective of evaluating the benefits of producing a reservoir utilizing horizontal wells drilled either from the surface or from underground tunnels, has had a very active year.

The project has been divided into two parts, Phase A, encompassing exploratory and engineering work, and Phase B, which will be the actual field activities.

Phase A proceeded on schedule and was completed by the end of 1981, and a final report was prepared. The exploratory drilling and geotechnical work necessary to locate a suitable pilot site was completed. The many options possible for the test, including well configuration, reservoir processes, mining alternatives, etc., were evaluated and recommendations made in regard to those which warrant further study. The work to date has indicated that it should be technically and economically feasible to deplete a reservoir using horizontal wells drilled either from the surface or from tunnels.

The decision on whether to proceed to Phase B, the field piloting operation, will be made by mid-1982, as originally scheduled in the AOSTRA Gulf Canada Resources Inc. agreement.

1.6 Data Base Management System

The AOSTRA Data Base System (ADBS) is a computerized system designed to house the operating data collected by in situ pilot projects. The data are stored in a format that provides for extensive reporting (tabular and graphical), including direct data access via computer terminals. These capabilities allow the ADBS to be used for project monitoring, assisting with evaluation of pilot performance, and generation of regular status reports.

The ADBS is intended for general use by industry and five companies currently are using the system.

2. ENHANCED RECOVERY PROGRAM

Several enhanced oil recovery projects in heavy oil reservoirs, initially funded under the AOSTRA in situ program, are described below. AOSTRA has been allocated an additional \$75 million to develop

methods for enhancing the production from conventional light and heavy oil reservoirs, and laboratory and feasibility studies have been initiated on four potential field projects.

2.1 AOSTRA - ALBERTA ENERGY Suffield Heavy Oil Pilot Project

The objective of the AOSTRA-Alberta Energy Company Ltd. Heavy Oil Pilot Project at Suffield, Alberta is to determine whether combustion methods can be used to produce heavy oil from a reservoir which has underlying water. There are numerous reservoirs of this type in the province and their primary recovery rates are uneconomic or, in some cases, marginally economic. Other participants in this project are Musketeer Energy Ltd. and Westcoast Petroleum Ltd.

The reservoir being investigated is the Glauconitic sandstone, 20 m (64 ft.) thick, at a depth of 900 m (2950 ft.). The test is located in the Suffield Block and consists of a single 5-spot pattern covering 2 hectares (5 acres). Combustion is being tested with air injection into the central well.

Construction and drilling are complete and air injection commenced in February 1982. Wells are on primary production at present. Injection and production operations are forecast to continue for four years.

2.2 AOSTRA - PETRO-CANADA Viking-Kinsella Pilot Project

The AOSTRA-Petro-Canada Exploration Inc. Viking-Kinsella project is located 80 km (49 miles) southwest of Lloydminster. The objectives of the project were to evaluate and compare the performance of steamflood and fireflood in thin Lloydminster-type reservoirs. These usually have a pay zone of under 5 m (16 ft.) and are only marginally economic under primary production. The depth of the reservoir is 680 m (2240 ft.).

Based on previous drilling, the reservoir was thought to be continuous. The northwest fire-flood (combustion) pattern came in as expected during drilling but, in the southeast steam pattern, the reservoir was truncated by an unmapped silty channel.

Operation of the steam pattern was terminated in December 1981. Air injection tests were hampered by corrosion problems in the injection wells and have been terminated except for one well, where results have been encouraging.

Plans are being formulated to continue the combustion test with the drilling of three new production wells to give a single inverted 5 spot on a reduced well spacing. It is expected that a decision on the future of this program will be made by mid 1982.

The steam pattern tests are being reviewed but the initial conclusion is that the process used is not suitable for this type of reservoir.

2.3 AOSTRA-Hudson's Bay Caustic Flood Test Program

Tracer tests were conducted on two wells in the Basal Colorado "A" Pool by Hudson's Bay Oil and Gas Company Limited in mid 1980 to evaluate this pool as a candidate for caustic water flooding. The technique was originally developed and tested by Conoco Inc. in Wyoming in 1979. The Cessford pool is located in south central Alberta, in a sandstone reservoir in the Lower Cretaceous, at a depth of 930 m (3000 feet). Gravity of the oil is approximately 26° API. The pool was discovered in 1958. Waterflood operations were initiated in early 1981. Primary recovery is estimated to be in the order of 15%. The test concluded that the technique was effective for determining residual oil saturations after a caustic flood. AOSTRA acquired the results of the tests in June 1981 and the report can be purchased from AOSTRA.

An agreement between Hudson's Bay and AOSTRA provides for potential jointly funded additional field work.

2.4 Heavy Oil Lifting Project

In 1979, AOSTRA and nine oil companies entered into an agreement with Pengalta Research and Development Ltd., a Calgary-based firm, to conduct a review of problems involved in lifting or pumping fluids from heavy oil wells.

The first phase, which included a determination of the state-of-the-art and a definition of the problems, is complete and a report has been submitted. Phase II involves the establishment of experimental facilities to develop solutions to the problems identified in Phase I.

The original ten participants have increased to fourteen and an agreement was reached to spend \$1.75 million on Phase II.

Several innovative pump designs are being examined and the first of these will be field tested shortly by Pengalta on behalf of AOSTRA and a number of the Phase II participants. It is expected that other designs will be tested as they become available as part of the Phase II work.

2.5 AOSTRA - Norcen Bodo Field, Laboratory Study

This joint project of AOSTRA and Norcen Energy Resources Limited involves laboratory studies on a comparison of steam flooding versus combustion in the Bodo field. This is a low gravity pool (13.5 API) producing from the Mannville "B" sandstone located in east central Alberta at approximately 735 m (2411 ft.). Norcen's partners in this project include Canada Cities Service Ltd., Canadian Reserve Oil and Gas Ltd., and Murphy Oil Company Limited.

The laboratory studies are essentially complete and comparative reviews of results will begin shortly.

Norcen and partners are operating a combustion pilot in the field at present. Depending upon the results of the current laboratory studies, AOSTRA may participate in a steam flood pilot in this field.

2.6 Cyclic CO₂ Stimulation Project

A project involving a series of CO₂ stimulation tests on three wells in the Lloydminster area is proceeding. Laboratory studies have been completed and two single well field tests are complete. It is expected that a formal agreement between AOSTRA and the operator will be concluded shortly.

2.7 Carbon Dioxide Flood

An Application for funding of a major "CO₂ flood" is under consideration. Discussions with several other operators are expected to result in additional applications.

2.8 Turbo Chemicals Steam Additives

The expenditure of \$25,000 has been authorized for the testing of two proprietary steam additives in a core evaluation facility at the Alberta Research Council. This work is expected to commence in April, 1982.

3. PRODUCED WATER RECYCLING PROGRAM

3.1 Application of Ultrafiltration and Reverse Osmosis

Large quantities of impure water produced in conjunction with the in situ recovery of bitumen and heavy oil must be treated for removal of residual oil and solids before the water can be recycled as boiler feed water. AOSTRA has participated with the Walden Division of Abcor Inc. in a series of field tests to examine the application of ultrafiltration membranes and reverse osmosis for treatment of produced water, at a cost of \$96,500. The final report on this project has been received and is being evaluated by an independent engineering contractor relative to conventional water treating processes to determine the incentives for carrying out further research.

3.2 Forced Convection Coil Flow Boilers

Forced convection coil flow boilers are in use in oil field applications to generate low quality injection steam for in situ recovery operations using impure boiler feed water. These boilers depend on the centrifugal forces established in the tube coil to maintain a thin film of water on the tube wall thereby avoiding scale formation. Because these forces are relatively weak, commercial coil flow boilers are limited in size, which may restrict their use in large scale in situ projects. The Waterloo Centre for

Process Development is conducting a bench-scale project to test a novel process by which the centrifugal forces may be reinforced, thereby allowing the water film to be maintained in a large capacity coil flow design. AOSTRA has provided funds in the amount of \$262,000 to carry out this project.

3.3 Produced Water Treatment Study

Many processes, and combinations of processes, exist for the treatment of boiler feed water. Because of the unique characteristics of water co-produced with heavy oil from in situ recovery operations, the selection of the most technically suitable and cost effective process in any given set of circumstances is a costly and time consuming exercise. AOSTRA, in conjunction with 11 companies, has initiated a cooperative study and test program to evaluate both conventional and unconventional water treating systems when applied to various types of produced water. The cost of the project is shared equally among the participants. A total of \$75,000 has been committed by the participants to carry out the organizational phase.

3.4 Microbial Upgrading of Produced Water

In 1980, AOSTRA entered into an agreement with GeoChem Laboratories (Canada) Ltd. to conduct an initial investigation of the use of micro-organisms to remove hydrocarbons from produced water. This study was completed and a report was submitted in March 1981. A Phase 2 study at a cost of \$164,725 was initiated in September, 1981 which involves bench-scale testing of produced water treatment systems, with particular emphasis on operation at elevated temperatures for energy conservation. This work is being conducted by Gemini Biochemical Research Ltd., which has acquired GeoChem Laboratories' rights to research in this field.

4. SURFACE MINING/EXTRACTION PROGRAM

4.1 Retco Electrophoretic Process

AOSTRA has entered the third phase of a project originally undertaken by Retco Engineering Ltd. and being continued by Xana Engineering Ltd. in Calgary, to test electrophoretic removal of fine solids from the tailings sludge generated by hot water extraction of bitumen from oil sands. The deposited solids are recovered, and disposed of, as a consolidated cake.

The objectives of this program are to reduce the size of settling ponds associated with hot water extraction and to increase the amount of clarified water available for recirculation to extraction. The laboratory phase was successfully completed in 1980. A continuous flow pilot has been constructed and commissioned in Calgary. Agreement has been reached with Syncrude Canada Ltd. under which a site will be provided at its Mildred Lake plant to test the performance of the Retco process under field conditions. AOSTRA has committed \$1.8 million to the development of this technology.

4.2 UMATAC Dry Retorting Process

AOSTRA and UMATAC Industrial Processes Ltd. are carrying out a pilot project based on retorting bitumen from oil sands using the Taciuk Processor. The Processor is a proprietary rotating vessel which combines the retorting of the bitumen from the sand, and burning of the deposited coke, within the same vessel. This processor may also be suitable for primary upgrading of heavy oils by using sand as a heat carrier.

Construction of a pilot plant in Calgary was completed in the spring of 1978. In excess of 2000 tonnes of oil sands have been processed in the pilot plant in a successful demonstration of the process concepts.

The second phase of the project is now underway. The purpose of the current program is to investigate specific process parameters, develop design correlations and to demonstrate the performance of the process by the continuous operation of the pilot plant over extended periods. Two companies, Canstar Oil Sands Limited and Gulf Canada Resources Inc., have agreed to participate in this phase as consultive participants. The total cost of the project to completion of the current phase is estimated to be \$5 million.

4.3 Lurgi Dry Distillation Process

AOSTRA commissioned a study to conduct a preliminary evaluation of the comparative economics of the Lurgi-Ruhrgas direct distillation process and the most advanced hot water process. Further to this study, AOSTRA negotiated an agreement with Lurgi to carry out a test run on a pilot unit in Essen, West Germany. This test was supported by AOSTRA at a cost of approximately \$600,000, and was completed in December, 1980. The results of the Lurgi tests did not fully confirm earlier performance predictions. As a result, AOSTRA plans to reassess the economic incentives for application of the process, based on the new test results, before proceeding with further research.

4.4 RTR Oil Sands Extraction Process

AOSTRA has entered into an agreement with Gulf Canada Resources Inc. and RTR-Rio Tinto Til Holding, S.A. to receive data from a project to demonstrate the performance of the RTR Oil Sands Extraction Process. The tests were carried out in a large field pilot located at the Suncor, Inc. plant site. The RTR process is a modified hot water extraction process that offers mild oil sands conditioning and internal water recirculation which, it is claimed, results in improvements in thermal and mechanical efficiencies relative to the conventional hot water process. A solvent water contacting device is employed to remove residual solids and water from the primary froth, yielding a diluted bitumen product. The results of the field tests are presently being evaluated.

AOSTRA's commitment to this project is \$100,000.

4.5 Kruger Oleophilic Sieve Extraction Process

Kruger Research and Development Ltd. of Edmonton has developed a novel method of separating bitumen from mined oil sands by means of an oleophilic sieve. This device captures the bitumen on the coated surface of a perforated continuous belt while allowing water and solids to pass through the clear openings. The process is claimed to provide higher bitumen yields and higher thermal efficiencies than the Clark hot water process. AOSTRA has provided \$260,000 to Kruger to construct and operate a small pilot on low grade (high clay content) oil sands. This test has been concluded and the final report is in preparation.

4.6 Proposed Oil Sands Demonstration Test Centre

Testing of new oil sands mining and extraction technologies, on a scale large enough to demonstrate the technical and economic viability of new equipment and processes, is a costly and difficult procedure due to the large quantities of feed required, and the need for extensive support facilities.

AOSTRA, in conjunction with eight companies holding mineable oil sands leases and the Federal Department of Energy, Mines and Resources, is investigating the feasibility of constructing an Oil Sands Demonstration Test Centre in the Fort McMurray area of Alberta. This Centre would be a cooperative, shared-cost facility to accommodate large scale, long term testing of new technologies that would be applicable to mined oil sands. Conceptual design and preliminary cost estimates have been prepared. Supporting studies to identify preferred sites for the Centre, potential users of the facility and the terms for participation in the ownership and operation of the Centre are underway. AOSTRA's commitment to the total cost of the feasibility study, in which all of the participants share equally, is \$43,000.

5. UPGRADING RESEARCH PROGRAM

5.1 Upgrading to Petrochemical Raw Materials

Conventional petroleum fractions for making petrochemical starting materials such as ethylene are becoming increasingly scarce and costly. The use of oil sands bitumen as a cracking feed for this purpose offers a plentiful supply of lower cost feed materials and an opportunity for substantial upgrading in value of certain components of the product over transportation fuels.

AOSTRA and Mitsubishi Petrochemical Co. Ltd. of Japan have completed testing a direct thermal cracking technique for the production of ethylene and other petrochemical feedstocks from bitumen. The program was carried out by the Alberta Research Council with technical assistance from Mitsubishi.

Two Alberta companies have expressed an interest in participating with AOSTRA in a detailed technical, commercial and economic evaluation of this process. Negotiations are underway with the Japanese government to obtain performance data from the operation of a 120 tonne per day pilot plant in Japan, which will form the basis for such an evaluation.

5.2 Heavy Oil and Bitumen Upgrading Study

New processes have been proposed for upgrading bitumen and heavy oil, many of which have the potential to achieve the objectives of higher liquid yield and reduced environmental impact. However, before any of these are ready for commercial application in Alberta, their performance must be demonstrated on a scale sufficient to allow commercial performance to be predicted with confidence.

AOSTRA has initiated a joint government industry study to rank the technical and economic potential of a number of candidate processes that are in various stages of development.

This study, which will examine the commercial potential of various emerging processes for large scale oil sands mining and in situ recovery operations and for small scale in situ recovery projects, is being carried out by Acres Davy McKee Ltd. at a total project cost of \$3.4 million. Half of this cost will be borne by AOSTRA.

The ultimate goal of this program, subject to the identification of promising new technology and the continued support of industry, is to construct and operate a large-scale plant to demonstrate the best process(es).

5.3 Application of Coal Processing Technology to Bitumen Upgrading

Certain processes being developed for liquefaction of coal might have application for upgrading oil sands bitumen. AOSTRA has entered into a \$168,000 program with Catalytic Inc. of Philadelphia, PA. to carry out small scale testing of supercritical solvent extraction of bitumen followed by hydrogen donor solvent treating of the extraction residue. The objective of the project is to determine whether or not this technology is capable of providing yield and quality improvements in bitumen upgrading. The results from this test work are currently being evaluated to determine the incentives for carrying out further research.

5.4 Thermal Conversion Process for Bitumen Upgrading

A new, high conversion thermal cracking process which incorporates steam stripping of the crackate, and which yields a liquid pitch residue, has been developed and used commercially in Japan. This process is called the Eureka Process.

AOSTRA has entered into an agreement with Mitsui & Co. Ltd., Kureha Chemical Industry Co. Ltd., and Chiyoda Chemical Engineering and Construction Co. Ltd., to test the performance of this process on Athabasca and Cold Lake bitumen feeds in an existing pilot plant in Japan. The test work associated with this \$338,000 project has been completed and the preparation of the final report is underway. Canstar Oil Sands Ltd. participated with AOSTRA in this project, paying twenty percent of the project cost.

5.5 Dynacracking

AOSTRA has agreed in principle to participate in the Calsyn joint venture for the construction and operation of a demonstration Dynacracker unit in California for upgrading residual oils. This is a new upgrading process which offers the potential to upgrade heavy oils without the production of residue. This process may be suitable for small applications in remote locations. Through participation in this project AOSTRA would secure specified Canadian rights to the technology and would be entitled to process Alberta feedstocks for test purposes.

5.6 Fluid Bed Combustion Test

AOSTRA furnished a large sample of fluid coke to Hans Ahlstrom Laboratory on behalf of Energy, Mines and Resources Canada (CANMET) to carry out a fluid bed combustion test in Finland. This test

was designed to develop data on combustion efficiency and effectiveness of flue gas desulphurization by lime addition to the fluid bed. A report on the results of this test has been received.

5.7 Resource and Energy Management System (REM)

The REM system is a concept for the integration of processes and operations to obtain maximum liquid products from upgrading bitumen and heavy oils, and at the same time obtain maximum utilization of energy. The system is applicable to carbon rejection processes and to hydrogen addition processes for upgrading bitumen and heavy oils. Key to the concept is gasification of a resid or coke (from primary conversion) to produce a fuel gas which can be desulphurized by H_2S removal (rather than handling SO_2 in a flue gas clean-up process), and use of the gas to generate electric power and steam in a combined cycle operation. Hydrogen requirements for upgrading would be supplied by electrolysis of water, with the oxygen produced being used in gasification.

In 1981, AOSTRA, in co-operation with Norcen Energy Resources Limited, and Energy Mines and Resources, Canada, undertook a technical and economic evaluation of the REM system as applied to small scale plants.

6. UNIVERSITY PROGRAM

6.1 Professorships

In the past seven years AOSTRA has appointed nine professors to chairs at Alberta universities to carry out advanced research on oil sands problems. The term of each initial appointment is 3 years, renewable for a further term of 2 years. The incumbent professors may also apply for additional funds for specific research projects.

- i) Dr. D.W. Bennion of the University of Calgary is studying the recovery of oil from deeply buried oil sands by means of underground combustion. He also conducts related investigations of oxidation reactions of oil.
- ii) Dr. M.B. Dusseault of the University of Alberta is studying the behavior and strength characteristics of oil sands in its native state, with the objective of developing procedures for safely mining the deposit at the surface and for obtaining access to the deeper deposits using shafts and tunnels.
- iii) Dr. L.G. Hepler of the University of Lethbridge is investigating clay oil water systems encountered in many aspects of the oil sands industry, with emphasis on tailings and water treatment.
- iv) Dr. E.C. Pielou of the University of Lethbridge is investigating the impact on the environment of oil sands development. Studies are to be carried out in the areas of reclamation and pollution.
- v) Dr. R.E. Robertson of the University of Calgary is conducting research on phase separation of the emulsions derived from the Alberta oil sands and heavy oils.
- vi) Dr. J.D. Scott of the University of Alberta is using analytical modelling techniques and laboratory and field experimental studies to increase basic knowledge on the geotechnical properties of oil sands.
- vii) Dr. T.J.T. Spanos of the University of Alberta is working on the mathematical simulation of in situ recovery processes, with emphasis on the fundamental equations that describe the dynamics of fluid flow and displacement.
- viii) Dr. O.P. Strausz of the University of Alberta is investigating the chemistry of the Alberta oil sands bitumens, with particular emphasis on the heavier fractions.
- ix) Dr. E.L. Tollefson of the University of Alberta will study the desulphurization of coke, and the fuel values of non-hydrocarbon constituents of oil sands, commencing July 1, 1982.

These professors devote approximately three-fourths of their time to oil sands research. The total funds committed to date for the professorship program is \$1.8 million.

6.2 Graduate Scholarships and Fellowships

The program to provide Scholarships and Fellowships for oil sands research at the University of Alberta, the University of Calgary and the University of Lethbridge has been extended for an additional 4-year period to provide for 8 new Fellowships and 25 new Scholarships.

The Scholarships are for a maximum period of two years and the research carried out will normally lead to either a Masters or Doctoral degree. Fellowships are for three years and are intended to assist post-doctoral level scientists to further their research training. Many of these individuals will eventually enter the sphere of industrial research. Current award holders are:-

UNIVERSITY OF
ALBERTA

Agar, J.G.
Berkowitz, B.S.
Chan, S.M.
*Cyr, T.G.
Gardiner, D.B.
Harding, T.G.
Hiebert, A.D.
Kowalchuk, K.K.
Sobkowicz, J.C.
Waywanko, A.O.

*Fellowship

UNIVERSITY OF
CALGARY

Kinrade, S.D.
Kulkarni, T.G.
*Ladd, T.I.
Lim, S.
Maier, R.
Oltman, P.

UNIVERSITY OF
LETHBRIDGE

*Campbell, J.S.

6.3 University Research Projects

Results of much of the earlier research conducted in universities with support from AOSTRA has been published or is being published in various technical journals or books. Results of more recent research, and of on-going research, can be obtained through AOSTRA's University Access Program.

Research in universities has led to one patent and eight patent applications. Use rights to these patents can be purchased from AOSTRA.

Current contracts are described briefly below:

- (1) Dr. F.W. Bachelor of the University of Calgary has been identifying and isolating the nitrogen-containing compounds present in bitumen. This research has been funded for a total of \$226,593 over 6 years.
- (2) Dr. D.W. Bennion and associates of the University of Calgary have carried out an extensive investigation of the combustion of oil sands, funded to a total of \$650,000 over 5 years.
- (3) Dr. P.M. Boorman and colleagues of the University of Calgary are investigating the catalytic desulphurization of bitumen, supported with \$282,800 over 4 years.
- (4) Dr. F.S. Chute and Dr. F.E. Vermuelen of the University of Alberta are measuring electrical properties of oil sands, developing physical models of electrical heating methods, and evaluating the use of electrical power for selective heating of oil sands. Their research has been supported for \$212,413 over 3 years.
- (5) Dr. J.E. Desnoyers of Universite de Sherbrooke is developing methods of investigating phase equilibria and other properties of oil-water microemulsions, with a view toward use of microemulsions for extraction of bitumen and heavy oil. These investigations have been supported by contracts for \$16,110 (1 year), \$65,000 (1 year), and \$97,094 (1 year).
- (6) Dr. T.H. Etsell of the University of Alberta has been developing an electrochemical probe for directly monitoring the sulphur content in gaseous mixtures. He has also been investigating the kinetics of coke gasification. Funding for these projects has been provided in the amount of \$118,884 for 2 years.
- (7) Dr. S.M. Farouq Ali of the University of Alberta has been investigating mathematical modelling to simulate fracturing and closing of fractures in cyclic steam stimulation systems and has also been investigating the utilization of emulsion flooding for the recovery of Cold Lake and Lloydminster heavy crudes. These projects have been funded to a total of \$155,572 over 4 years.

- (8) Dr. D.L. Flock of the University of Alberta is studying the effects of additives to steam on the degree of emulsification of oil in water and the relationships of these effects to overall recovery by cyclic steam stimulation and steam displacement. This will be a 3 year project for \$300,000.
- (9) Dr. J.E. Gillott of the University of Calgary is investigating the changes in strength, dimensional change, permeability and bond characteristics of oilwell cements after hydrothermal treatment in the presence of formation fluids and drilling muds. This is a 2 year project for \$61,689.
- (10) Dr. R. Gilpin of the University of Alberta investigated the parameters that affect the cutting of oil sands by a high pressure water jet, funded with \$24,180 (2 years). Dr. E.M. Gates has extended and expanded this investigation to include the possible use of down-hole jets, with funding now totalling \$53,977.
- (11) Dr. L.G. Hepler of the University of Lethbridge has investigated problems in colloid chemistry and thermodynamics related to tailings treatment and water treatment. This work has recently been extended to include measurements of specific heats of oil sands and components. Funding has amounted to \$252,724.
- (12) Dr. J.B. Hyne of the University of Calgary has been investigating the reactions of bitumen, emphasizing sulphur-containing compounds, with water at high temperature and pressure, comparable to in situ recovery conditions. Petro-Canada Exploration Inc. and INTEVEP of Venezuela have purchased access to this program by paying 25% and 50%, respectively, of the cost and are participating in technical planning. This project has been funded for \$1,106,621 over a 7 year period.
- (13) Dr. A. Jeje of the University of Calgary is measuring the rate of CO_2 mass transfer into films of oil supported on glass or silica plates to obtain background information on the influence of film thickness and the role of the supporting surface upon the rate of CO_2 transfer into the hydrocarbon film. This will be an 18-month project costing \$42,320.
- (14) Dr. G.A. Karim of the University of Calgary has investigated several problems related to the combustion of bitumen associated with sand grains. This research has been funded for a total of \$82,612 over 4 years.
- (15) Dr. N. Kosaric of the University of Western Ontario is investigating the use of bacteria and bacterial products for breaking emulsions that are formed during production of bitumen and heavy oils, funded with \$76,147.50 over 13 months.
- (16) Dr. H.R. Krouse of the University of Calgary is directing a program designed to provide gas chromatography mass spectrometry and stable isotope mass spectrometry analytical facilities, along with new methods of analysis. Funding is \$248,040 over a 3-year period.
- (17) Dr. K.G. McCurdy of the University of Lethbridge has measured the solubilities and rates of solution in water of some minerals that occur in the Alberta oil sands. This research has been funded for a total of \$38,234.
- (18) Dr. A.K. Mehrotra of the University of Calgary is studying treatment of in situ produced water for recycling to boilers. This one year project is for \$17,136.
- (19) Dr. M.F. Mohtadi of the University of Calgary is studying the development of a process for recovery of heavy oil from reservoirs involving downhole generation of steam. This research has been supported for 15 months at \$63,659.
- (20) Dr. N.R. Morgenstern and Dr. J.D. Scott of the University of Alberta have designed and set up a high temperature, high pressure test facility and are using the facility in measuring strengths, deformabilities, and permeabilities of oil sands at temperatures and pressures encountered in in situ production. This work has been funded to a total of \$92,160 over a 2 year period.
- (21) Dr. E.W. Neumann of the University of Toronto has developed a new method for investigating interfacial tensions, which is being applied to oil sands systems. Funding for this research is \$97,645 over 2 years.
- (22) Mr. E. Peake of the Kananaskis Center for Environmental Research at the University of Calgary is assessing environmental hazards and human health risks that might arise from toxic and carcinogenic substances that could be generated during in situ fireflood production from oil sands. Funding for this

research has been \$217,000 over 2 years, with costs shared equally between AOSTRA and Alberta Environment.

(23) Dr. E.C. Pielou of the University of Lethbridge is investigating the effects of S_0 on various plants involving both field testing and greenhouse experiments. This one year project is for \$30,000.

(24) Dr. D. Rankin of the University of Alberta is investigating application of the magnetotelluric method for flame front detection in in situ combustion, funded for 2 years at a cost of \$147,660. He has also directed a project for development of a new method of measuring steam quality and mass flow for steam-based in situ recovery, for which funding has been \$56,280 (1 year).

(25) Dr. R.E. Robertson of the University of Calgary has carried out an extensive range of investigations of emulsions, funded for a total of 415,338 for a 6 year period.

(26) Dr. D.B. Robinson of the University of Alberta is measuring phase relationships of bitumen with gases, liquids, and steam under conditions of in situ recovery. This research has cost \$250,720 over 3 years.

(27) Dr. R.S. Roche of the University of Calgary is investigating the energetics, kinetics, and catalysis of pyrolysis (cracking and coking) of bitumen. This research will cost \$689,923 over 7 years.

(28) Dr. T.S. Sorensen of the University of Calgary is directing a chemical investigation of hydrotreating bitumen under various conditions of temperature, pressure, and catalyst type. This project is for \$98,171 over 2 years.

(29) Dr. T.J.T. Spanos of the University of Alberta is conducting mathematical analyses of fluid flow properties in relation to in situ production. This research has been funded with \$35,546 (1 year).

(30) Dr. O.P. Strausz at the University of Alberta is directing two research projects. One project is a detailed and extensive investigation of the chemistry of the asphaltene and resin fractions of bitumen, funded with \$307,076 (38 months). The other project, directed at development of an improved upgrading process for bitumen, is funded to \$254,292 over 38 months.

(31) Dr. O.P. Strausz and Dr. D.S. Montgomery at the University of Alberta are investigating the causes of poor separability of bitumen from low grade oil sands. The research is funded at \$351,996 over 43 months.

(32) Dr. W.Y. Svrcek of the University of Calgary has been investigating the solubilities of gases in bitumen and the viscosities of the resulting gas-bitumen solutions. Total funding has been \$203,000 over 3 1/2 years.

(33) Dr. E.L. Tollefson of the University of Calgary has been investigating the technology and economics of desulphurizing oil sands coke. Funding for this research has been \$48,930 (8 months) and \$93,500 (1 year).

(34) Dr. R.E. Verrall of the University of Saskatchewan is using ultrasonic absorption methods for investigating the dynamics of surfactants in ternary and quaternary microemulsions. This research has been funded for \$47,020 over a 2-year period.

(35) Dr. R.C. Von Borstel of the University of Alberta is directing an evaluation of the possible mutagenicity of various process streams resulting from in situ pilot projects and bitumen refining operations, funded at \$198,668 over 3 years.

(36) Dr. J.K.S. Wan of Queen's University is investigating the possibility of upgrading pitch from Athabasca bitumen by a multiphoton microwave induced catalytic hydrocracking process. This 8-month project costs \$27,440.

7. ALBERTA RESEARCH COUNCIL PROGRAM

The Alberta Research Council (ARC) is performing a substantial portion of AOSTRA's laboratory type research. Some of these projects are described below:

7.1 Oil Sands Laboratory Research

Effective April, 1, 1981, AOSTRA and the Alberta Research Council entered into a new five-year

agreement to carry out a joint research program which is, in part, a continuation of the program conducted in preceeding years at the ARC under 100% AOSTRA sponsorship. A total of \$4.2 million was expended during the 1981-82 fiscal year. AOSTRA paid 60% of the total cost (\$2.5 million) and ARC the remainder. The major program was to investigate in physical test bed simulators the benefits from the addition of various additives to the injected steam. Other research programs included physical parameters determination, physical chemistry investigations, fluid-rock interactions and bitumen chemistry studies.

It is proposed to initiate an access program to provide for the dissemination of the results of the ARC work to industry on a cost sharing basis. A summary of the current status of some of the projects is given below:-

7.1.1 150 cm Physical Simulator

In situ bitumen recovery methods involve interactions between many variables which obey complex, and often contradictory, scaling laws. As a result, scaled experiments are extremely difficult. Numerical modeling of these processes is also complicated due to the uncertainty in mechanisms and the empirical nature of many of the parameters used.

The objective of the research on the large simulator is to conduct rigidly controlled tests of proposed recovery processes and attempt to predict the results by numerical simulation. These data should be of significant value for predicting process performance in the field.

Ten experiments have been conducted using this equipment. Four of these experiments used steam only; four used steam and CO₂; while one used steam, CO₂ and naphtha.

Twenty-six reports and one technical paper are available, evaluation of results is continuing.

AOSTRA share of Project Cost: \$2,478,000

7.1.2 45 60 cm Physical Lab Cell Simulators

One hundred and three experiments have been conducted using the 45 60 cm simulators. These were as follows:

steam only	19
steam and gases (CO ₂ , N ₂ , Light hydrocarbons)	23
steam-solvent	11
steam-solvent-gases	17
steam-surfactant	3
hot-water additive	3
gaseous additive only (no heat)	2
packing procedures, equipment tests	9
incomplete and or aborted	16

One hundred and eight reports and eight technical papers have been written. The project also resulted in five public presentations and two patents.

AOSTRA share of Project Cost: \$1,126,200

7.1.3 Mathematical Reservoir Simulation

Although physical simulators can be used to demonstrate bitumen recovery from an element of oil sand, they cannot provide quantitative, predictive results applicable to field situations. However, this can be achieved by an appropriate mathematical model. In addition, a model can be used to direct and reduce the number of physical simulations and increase the understanding of the processes taking place.

The study is concerned with the development of mathematical models which will describe the processes occurring in the 150 cm simulator in order to develop predictive capabilities for field application.

A 3-phase, 2-component, 3-dimensional implicit numerical steam simulator and a 4-component, 3-phase, 3-dimensional IMPES numerical steam simulator have been developed and operated. In addition, development of a 4-component, 3-phase, 3-dimensional implicit compositional numerical steam simulator will allow for solubility of any component in any of the three phases. This model has been developed and verification using the 150 cm physical model data is underway.

Five reports and one publication were prepared on this project and it was shown that starting from first principles, the results of a steam-only run with pressure drawdowns on the 150 cm physical simulator could be predicted.

AOSTRA share of Project Cost: \$499,800

7.1.4 *Economic Model*

This study is concerned with taking the data obtained from physical and numerical simulations of the recovery process, and estimating the recovery parameters for a hypothetical field case. The economics of this hypothetical field case are then evaluated using the Alberta Research Council's economic model.

AOSTRA share of Project Cost: \$24,600

7.1.5 *Physical Chemistry*

The extraction of bitumen from oil sands involves the mobilization of bitumen and the transport of the bitumen plus formation water and injected fluids through the reservoir and into the production well. An understanding of the mechanisms by which these processes occur, and how they are influenced by the various additives and operating conditions employed, may result in better mathematical representation of recovery processes, suggest improvements to existing processes, and lead to new recovery processes not yet envisioned.

The object of this research is to obtain an accurate description of the structure of oil sands; to describe and quantify the initial stages of bitumen displacement; to study the flow of bitumen and other process fluids through the reservoir; and to study the effect on these processes of the addition of agents such as surfactants, or the change in operating conditions such as pressure and temperature.

The research has resulted in seven reports, five technical papers, and eight technical presentations. Research has resulted in a new model for the structure of oil sand and greater understanding of the fluid flowing in the reservoir in relation to that observed at the production ports.

AOSTRA share of Project Cost: \$877,200

7.1.6 *Fluid-Rock Interaction*

When agents such as steam and hot water are injected into a reservoir, the mineral matter in the reservoir reacts with these agents to produce a complex ionic solution. As conditions of temperature, pH and ionic concentration change within the reservoir, the solution becomes supersaturated with respect to new mineral species and, depending on the kinetics of the process and the existence of nucleation sites, new minerals are formed.

The object of this study is to qualitatively understand the fluid-rock interaction processes which are going on in a reservoir, and, through a study of the kinetics and thermodynamics of the process, develop a quantitative model of mineral dissolution and precipitation and their effect on permeability.

This study has resulted in five reports and seven papers and has determined the dissolution rates of silica from oil sands as a function of temperature, pH and presence of bitumen; the minerals that supersaturate the solution; the growth of new minerals in the pore structure, and the major factors that influence mineral transformations and water chemistry.

AOSTRA share of Project Cost: \$630,000

7.1.7 *Alkali Recycle and Bitumen Chemistry*

The object of this research is to characterize the surface-active components in the bitumen that play a role in emulsion stabilization and to optimize the conditions for emulsion breaking and alkali recovery.

The emulsion-breaking part of the cycle has been used successfully on emulsions produced from the 150 cm simulator.

AOSTRA share of Project Cost: \$23,400

7.1.8 *Analytic Methods Development*

The objectives of this research program are: the development of more accurate and cost-effective methods of measuring bitumen, water, and solids concentration in produced fluids; components in bitumen; ionic concentrations in produced fluids; fluid saturations in samples from physical simulators; the development of non-destructive testing methods for measuring fluid and gas saturations in cores, and the provision of analytical consulting services to other programs.

This work has resulted in ten technical reports and three publications. It has resulted in a marked increase in the speed and accuracy of analytical procedures as well as the development of new techniques.

AOSTRA share of Project Cost: \$343,800

7.1.9 *Reservoir Simulation*

The object of this study is to determine the degree to which oil sand is altered on repacking by a study of undisturbed oil sands samples, repacked samples, and samples following recovery tests.

Seven technical reports were written on this work. These reports deal mainly with the fracturing of oil sand reservoirs and the changes which occur in an oil sands sample on being repacked or reconstituted.

AOSTRA share of Project Cost: \$61,200

7.1.10 *Basic Physical Parameter Determination*

In order to numerically simulate recovery of novel recovery processes taking place in physical simulators, it is necessary to have information on six parameters over the temperature, pressure, and concentration gradients present during the recovery process. These six basic parameters are: relative permeability; pressure-volume-temperature thermodynamic data; viscosity; diffusion; capillary pressure, and heat transfer.

This program is designed to obtain these data for the recovery processes being developed using physical and numerical simulators. Initial emphasis has been on relative permeability, P.V.T. data, diffusion and viscosity.

Sixteen reports and publications have been written as a result of this work. These reports deal with:

- (a) literature searches of parameter data;
- (b) end-point relative permeabilities of Athabasca oil sands as a function of temperature;

(c) initial work on the diffusion of gases into oil sands.

AOSTRA share of Project Cost: \$724,200

7.1.11 Instrumentation

The object of this project is to provide new apparatus and facilities for simulation of bitumen recovery processes and to test existing equipment for reliability and integrity.

AOSTRA share of Project Cost: \$34,200

7.2 Sample Bank

AOSTRA reached agreement with the Alberta Research Council to fund the Sample Bank for a further three years beginning April 1, 1981 for a sum of \$637,680. During the first year, support of this program cost \$336,110. The Sample Bank continues to provide such services as collection, storage, distribution and analyses of various oil sands and bitumen samples. The number and volume of shipments for the Sample Bank increased by 27 % this year compared to the previous year.

7.3 Geology

In early 1980 AOSTRA agreed to provide \$1,915,000 to the Alberta Research Council to conduct regional geological studies in oil sands, carbonate and heavy oil areas. To carry out this work ARC has increased its professional and technical staff and will make the services of certain senior personnel available. The contract provides for work to continue over a four year period.

The initial work involved a technical audit of geological data available from AOSTRA's industrial participants. This work has been completed and forms the basis for the regional studies which are continuing in the Athabasca, Cold Lake and Carbonate reservoirs. A detailed geological study of the Suffield Block also has been completed.

A detailed report on possible locations for a new pilot in the Gregoire Lake area of Athabasca has been prepared.

An ARC geologist has been assigned to the technical committee of each AOSTRA field pilot in order to provide geological input.

7.4 Oil Sands Information Centre (OSIC)

The Alberta Oil Sands Information Centre has continued its role of collecting and disseminating information related to oil sands. These activities are being expanded to include information on enhanced oil recovery and heavy oil. There is an existing agreement between AOSTRA and the Alberta Research Council, effective May 31, 1980, wherein AOSTRA agrees to support the Centre until May 31, 1985 with a total budget of \$2.1 million.

The Centre publishes a quarterly Alberta Oil Sands Index (AOSI) and provides on-line access to computerized AOSI database with bi-weekly updated information. Along with other publications, the Information Centre distributes a news letter called the "Tar Paper", which contains items of interest to oil sands people and is available free upon request.

The Centre has provided a major information package to the UNITAR UNDP World Information Centre in New York, as described in Section 9.

8. PETROLEUM RECOVERY INSTITUTE PROGRAM

In the 1981-82 fiscal year, AOSTRA made provision for the expenditure of \$300,000 by the Petroleum Recovery Institute in Calgary for engineering studies of enhanced oil recovery (EOR) possibilities in Alberta. Enhanced oil recovery processes are sensitive to specific reservoir conditions and to specific rock and fluid parameters. The research program is specifically directed towards identifying suitable locations for tests of particular EOR processes.

9. INTERNATIONAL PROGRAM

During the 1981-82 period, there continued to be a high level of interest by AOSTRA in international technical exchanges. AOSTRA maintains contacts with other countries to be aware of all activities which could impinge on its research efforts and to seek opportunities to acquire, sell, or exchange technology. There is also the prospect for use of Canadian expertise and services.

AOSTRA had meetings during the year with representatives from the following countries:

- Argentina
- Brazil
- Ecuador
- France
- Indonesia
- Italy
- Japan
- Kuwait
- Nigeria
- Oman
- Romania
- United States
- Venezuela
- Yugoslavia

AOSTRA staff members or AOSTRA-sponsored individuals visited:

- Argentina (to sign a technology exchange agreement)
- Brazil (to study oil sands deposits)
- Kuwait (to review thermal pilot plans)
- Nigeria (to review a proposal for an R and D laboratory)
- Romania (to jointly study, with Romconsult, the feasibility of a combustion project)
- United States (to review plans for a joint project)
- Venezuela (to review progress in joint projects)

AOSTRA was a major sponsor of the UNITAR Conference held in Caracas, Venezuela during the period February 7 to 17, 1982. This conference was hosted by UNITAR and Petroleos de Venezuela and had AOSTRA and the U.S. Department of Energy as co-organizers. During the UNITAR conference, the offer was made by AOSTRA to give to the UNITAR UNDP Information Centre for Heavy Crude and Tar Sands, in New York, copies of the 7000 documents in AOSTRA's Oil Sands Information Centre. The offer provides the New York facility with a comprehensive library of oil sands literature. In addition, AOSTRA offered to provide computer access to its information system based in Edmonton.

9.1 *Nonconventional Hydrocarbon Fuels Developments*

A review and analysis of U.S. policies and activities in nonconventional hydrocarbon fuels development, conducted by McKinsey & Company of Washington, D.C., is being jointly funded by AOSTRA and Alberta Energy and Natural Resources at a total cost of \$150,000. The principal topics covered in the study are coal liquifaction, heavy oil upgrading, oil sands and oil shale development, and enhanced recovery of conventional crude oil. The project commenced in February, 1982 and is scheduled to be completed in June, 1982.

10. TRAINING PROGRAM

10.1 *Master's Program in Oil Sands*

A Master's in Oil Sands Degree Program has been established by the Faculty of Engineering at the University of Alberta and a number of students are supported by AOSTRA during the academic period to ensure well qualified technical personnel are available to work in the oil sands industry.

The Program is designed so that engineers and scientists, with or without previous oil sands experience, can obtain a Master's degree in subjects oriented towards the oil sands industry. In this co-operative Program, students formally integrate their academic study with work experience on oil

sands projects. The financial support from AOSTRA is designed to remove the economic obstacle for students already in the work force and who desire to obtain a higher degree in this new field of study.

During the 1981-82 fiscal year \$206,928 was spent on this Program. This amount covers academic support for thirteen students and academic support plus employee wages for six students.

10.2 University Summer Students and Co-Operative Program

In continuation of the AOSTRA policy to promote career opportunities in the oil sands industry, AOSTRA hires university summer students and students working in co-operative programs at Canadian universities. This early exposure to AOSTRA and the oil industry will hopefully encourage the students to obtain positions in the oil sands industry upon graduation.

AOSTRA employed four summer students during the year at a cost of \$29,670 and three students from a co-operative program at a cost of \$25,673.

10.3 Oil Sands Short Course

A one-week technical course on non-conventional oils was sponsored by AOSTRA. It was anticipated that, through specialized training the qualifications of those currently in the industry could be enhanced and, by attracting new people to this area, some contribution could be made to fulfilling anticipated manpower needs. The introductory course was given at Banff. More advanced courses will be instituted if justified.

11. METHODS OF ACCESS TO ONGOING AOSTRA PROJECTS

During the fiscal year \$3,477,561 was generated by the sale of technology under the following projects:

11.1 Joint Industry Projects

AOSTRA has developed a procedure whereby interested parties may obtain access to the technical information from an ongoing project. Such parties are designated "Consultive Participants" and obtain access to the patents and technical information produced, including the related prior technology owned by the company involved in the project. The access fee depends on the nature of the project, and is a relatively small percentage of the cost of the project. Consultive Participant access to the AOSTRA-Gulf Surmont project, the AOSTRA-Union Buffalo Creek project, the AOSTRA-BP Marguerite Lake project and the AOSTRA-AEC Suffield project have been offered. One company has joined the AOSTRA-Union Buffalo Creek project as a Consultive Participant. Terms of access to other AOSTRA-Industry projects will be made public in the coming year.

11.2 University Research Projects

Generally, the results of AOSTRA's university research projects may be published by the researchers one year after the final report has been received by AOSTRA. All patents are owned by AOSTRA. AOSTRA has developed two programs to expedite the use by Industry of new concepts developed at Canadian Universities. Ongoing access to AOSTRA's university projects, including the use of inventions, may be obtained for less than 5% of the total program cost. Twenty-three companies currently participate in this access program. Access to a single project may be obtained by paying 25% of the actual cost. This year, for the first time, some industry representatives from the participating companies have been appointed to the evaluation panel, which recommends university projects appropriate for AOSTRA support.

11.3 AOSTRA 100% Funded Projects

AOSTRA is supporting some projects by paying all direct costs. These projects are mostly those proposed by small companies or individuals. Although AOSTRA is prepared to fully fund such projects through the early development period, it is desirable at the later stages to have technical

and financial support from industry. AOSTRA will advise industry when opportunities for joint participation in such projects are available.

11.4 Data Base Management System

AOSTRA has developed a successful computerized system that provides secure storage, manipulation and retrieval of data from field pilots. The system provides up-to-date reports in special formats. Any company wishing to make use of the system for storing and manipulating its own data can make arrangements with AOSTRA and the computer company for this service. Terms for use include a one time cost for the customization of a specific project to the ADBS format and a monthly operational fee that is related to the amount of use.

11.5 Completed Reports

Annually, AOSTRA sells selected reports, data and access to completed projects. In this manner, technical information is rapidly brought to the attention of potential users.

12. PATENTS

12.1 AOSTRA Patents

The following patents and patent applications are assigned to AOSTRA:

a) U.S. Patents

U.S. Patent No.	Date Issued	Patent Title
4,180,455	Dec. 25 79	Process for Thermal Cracking a Heavy Hydrocarbon (W. Taciuk)
4,280,879	July 28 81	Apparatus and Process for Recovery of Hydro- carbons from Inorganic Host Materials (W. Taciuk)
4,306,961	Dec. 22 81	Process for Recovery of Hydrocarbons From Inorganic Host Materials (W. Taciuk Tarsand Version)
4,285,773	Aug. 25 81	Apparatus and Process For Recovery of Hydro- carbons from Inorganic Host Materials (Taciuk Lloydminster Version)
4,312,234	Jan. 26 82	Two Phase Flow Meter (D.S. Scott and E. Rhodes)
4,271,905	June 9 81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen From Tar Sands (D.A. Redford and M.R. Hanna)

b) U.S. Patent Applications

U.S. Patent Application No.	Date Filed	Patent Application Title
148,399	Feb. 19 81	Process for Microbiologically Leaching Coke (T.R. Jack et al)
06 330,162	Dec. 14 81	Electrophoretic Process for Separating Aqueous Mineral Suspensions (R.A. Ritter)
06 286 843	July 27 81	Catalytic Sulphur Removal from Hydro- carbons (P.M. Boorman et al)
06 229,349	Jan. 29 81	Wet Combustion Process (D.W. Bennion et al)
06 294,523	Aug. 20 81	Variable Speed Pump Jack (D.L. Buckler)

c) Canadian Patents

Canadian Patent No.	Date Filed	Patent Title
1,120,418	Mar. 23 82	Process and Apparatus for Thermally Processing Heavy Hydrocarbon Containing Liquids (W. Taciuk)
1,121,749	Nov. 12 79	Apparatus and Process for Recovery of Hydro- carbons from Inorganic Host Materials (W. Taciuk)
1,102,234	June 2 81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen From Tar Sands (D.A. Redford and M.R. Hanna)

d) Canadian Patent Applications

Canadian Patent Application No.	Date Filed	Patent Application Title
334,885	Jan 26 82	Process for Micro- biologically Leaching Coke (T.R. Jack et al)
368,339-9	Jan 12 81	Two-Phase Flowmeter (D.S. Scott & E. Rhodes)
369,403-8	Jan 27 81	Wet Combustion Process (D.W. Bennion, R.G. Moore & J.K. Donnelly)
378,386-3	May 26 81	Electrophoretic Process for Separating Aqueous Mineral Suspensions (R.A. Ritter)
369,403-8	July 7 81	Wet Combustion Process (D.W. Bennion et al)
383,910-9	Nov 6 81	Variable Speed Pump Jack (D.L. Buckler)

e) Venezuela Patent Applications

0067	Jan 21 81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
1933	Oct 31 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
108 82	Jan 22 82	Wet Combustion Process (D.W. Bennion et al)

f) Mexico Patent Applications

179,758	Oct 24 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
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g) European (EEC) Patent Applications

79,302,542.0	Nov 13 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
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h) Argentina Patent Applications

279,427	Dec 21 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
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i) Romania Patent Applications

99095	Oct 30 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
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j) Turkey Patent Applications

14426	Dec 21 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
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k) Japan Patent Applications

138227 79	Oct 25 79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon - Containing Liquids (W. Taciuk)
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12.2 Prior Company Patents

(for which AOSTRA has acquired certain Licensing Rights)

a) U.S. Patents

	U.S. Patent No.	Date Issued	Date Filed	Related Canadian Patent No.	Patent Titles
1.	3152638	10-13-64	7-15-60	711082	Underground reverse combustion process
2.	3154142	10-27-64	11-10-60	678012	Method of producing petroleum by underground combustion
3.	3154143	10-27-64	7-13-61	678088	Underground combustion process

a) U S. Patents Continued

	U S Patent No	Date Issued	Date Filed	Related Canadian Patent No	Patent Titles
4.	3155160	10-03-64	11-27-59	681248	Recovery of heavy oils by steam extraction
5	3163216	11-29-64	12-15-61	710139	Use of water injection for promoting uniform initiation of underground combustion
6.	3174544	4-01-65	5-15-64	—	Recovery of petroleum by combination reverse - direct in situ combustion
7.	3196945	7-27-65	10-02-62	—	Method of forward in situ combustion with water injection
8.	3239405	3-08-66	11-04-63	—	Underground combustion process
9.	3332480	7-25-67	3-04-65	776487	Recovery of hydrocarbons by thermal methods
10.	3372750	3-12-68	11-19-65	827466	Recovery of heavy oils by steam injection
11.	3375870	4-02-68	11-19-65	827467	Recovery of petroleum by thermal methods
12.	3384172	5-21-68	11-19-65	—	Producing petroleum by forward combustion and cyclic steam injection
13.	3399722	9-03-68	5-24-67	847137	Recovery of petroleum by a cyclic thermal method
14.	3434544	3-25-69	12-22-66	—	Method for conducting cyclic steam injection recovery of hydrocarbons
15.	3459265	8-05-69	7-28-67	849320	Method for recovering viscous oil by steam drive
16.	3460621	8-12-69	5-22-67	848245	Cyclic steam injection and gas drive
17.	3464491	9-02-69	12-18-67	848244	Oil recovery from formations containing channels
18.	3481399	12-02-69	6-10-68	866576	Recovery of oil by flashing of heated connate water
19.	3504745	4-07-70	5-08-68	853995	Use of foams to prevent vertical flow in tar sands during in situ combustion
20.	3547195	12-15-70	6-19-69	881914	Pyrolytic plugging of oil bearing formations by underground combustion

a) U.S. Patents Continued

	U S Patent No	Date Issued	Date Filed	Related Canadian Patent No	Patent Titles
21.	3430700	3-04-69	10-16-66	852555	Recovery of petroleum by thermal methods involving transfer of heat from one section of an oil bearing formation to another
22.	3729337	4-24-73	4-20-70	—	Production of petroleum from unconsolidated formations
23.	3964547	6-22-76	10-29-74	972679	Use of tar as a diverter in steaming operations
24.	4147213	4-03-79	—	—	Combustion air injection well

b) Canadian Patents

	Canadian Patent No.	Date Issued	Date Filed	Related U.S. Patent No.	Patent Titles
1.	710136	5-25-65	2-09-61	—	Oil well reverse combustion process
2.	710137	5-25-65	2-09-61	—	Method for conducting underground reverse combustion
3.	721099	11-09-65	10-02-59	—	Oil recovery by combustion
4.	739768	8-02-66	4-10-61	—	Underground combustion method
5.	739769	3-02-65	4-30-62	3171479	In situ combustion
6.	746725	11-22-66	12-08-58	—	Recovery of petroleum by underground combustion
7.	787182	6-11-68	10-18-63	3244229	Production of fluids from unconsolidated formations
8.	794324	10-10-68	5-04-65	—	Separation process
9.	794670	10-17-68	10-27-65	—	Method of producing hydrocarbons
10.	803818	1-14-69	5-13-66	3244229	Production of fluids from unconsolidated formations
11.	806945	2-25-69	12-06-65	—	Well pump
12.	815802	6-24-69	11-22-66	—	Valve for obtaining a sample of the fluid flowing in a pipeline
13.	820083	8-12-69	2-20-67	3366177	Production of petroleum from unconsolidated formations

b) Canadian Patents Continued

	Canadian Patent No	Date Issued	Date Filed	Related U.S. Patent No.	Patent Titles
14.	839042	4-14-70	3-18-66	—	Method of producing hydrocarbons from a subsurface formation by thermal treatment
15.	840211	3-28-70	1-17-66	—	Method of recovering hydrocarbons from an underground hydrocarbon containing formation
16.	840789	5-05-70	1-17-66	—	Method of producing hydrocarbons from an underground formation
17.	856023	11-17-70	2-23-68	—	Consolidating earth formations
18.	858309	12-15-70	2-23-68	—	Thermal secondary recovery
19.	890741	1-18-72	2-21-69	—	Method of recovering hydrocarbons from an underground hydrocarbon containing formation
20.	941735	2-12-74	6-01-71	—	Oil recovery using steam chemical drive fluids

TABLES

TABLE 1

Funding Requests Contained in Applications
Received Since Inception of Authority
to March 31, 1982

Type of Application	No.	Project Value	AOSTRA Funding Requested
In Situ (Oil Sands and Heavy Oil)			
From the Surface	48	831,363,082	367,284,041
From Underground Access	5	30,701,200	16,860,200
Underground Mining	7	9,229,310	9,229,310
Surface Mining and Extraction	34	47,906,642	37,891,642
Bitumen Upgrading	19	31,651,420	30,983,028
Universities	198	30,887,933	30,887,933
Other	67	34,241,946	30,073,834
TOTAL	378	\$1,015,981,533	\$523,209,988

TABLE 2

Summary of Funds Committed and Disbursed
to March 31, 1982

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1 81 to March 31 82	Balance
Institutional Research				
Alberta Research Council				
— Information Centre	\$ 3,100,000	\$ 1,313,017	\$ 394,205	\$ 1,392,778
— Oil Sands Research Centre	11,868,027	8,862,613	2,869,308	136,106
— Sample Bank	1,002,868	365,188	240,975	396,705
— Geological Program	1,915,009	421,795	469,740	1,023,474
University Contracts	8,961,678	5,513,285	2,103,367	1,345,026
Professorships	1,838,026	884,043	472,084	481,899
Scholarships and Fellowships	780,000	500,638	201,760	77,602
Ontario Research Foundation	10,700	4,477	1,622	4,601
University Access Program	100,000	26,882	44,159	28,959
	\$29,576,308	\$17,891,938	\$ 6,797,220	\$ 4,887,150
Mining and Extraction				
Retorting				
— Umatac	\$ 5,000,000	\$ 3,098,213	\$ 1,348,402	\$ 553,385
— Lurgi	662,220	621,165	—	41,055
Tailings Treatment				
— Xana	1,824,879	742,338	617,160	465,381
— EcoPlastics	63,318	59,917	—	3,401
Tunnelling	177,390	177,390	—	—
Dredging	27,658	27,658	—	—
Solvent Study	26,343	26,343	—	—
Oil Sands Demonstration Centre	275,000	23,069	18,253	233,678
Kruyer Research	260,000	—	240,000	20,000
R.T.R. Project	100,000	—	100,000	—
	\$ 8,416,808	\$ 4,776,093	\$ 2,323,815	\$ 1,316,900

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1 81 to March 31 82	Balance
In-Situ Oil Sands				
Peace River				
— Shell	\$63,039,351	\$49,337,578	\$ 7,413,067	\$ 6,288,706
Athabasca				
— Amoco	26,947,108	22,706,481	1,865,234	2,375,393
— Numac Gulf	1,650,661	1,449,500	(36)	201,197
— Hudson's Bay	100,000	36,843	—	63,157
— Gulf	4,960,143	3,468,697	1,461,788	29,658
Cold Lake				
— B.P.	21,951,500	9,295,950	3,231,266	9,424,284
Consultants	36,430	30,600	—	5,830
Gemini	264,211	99,487	123,544	41,180
Walden	96,500	87,268	9,346	(114)
Monenco	35,000	—	35,000	—
Waterloo Centre	262,190	—	111,333	150,857
Electrical Heating Study	20,000	—	6,294	13,706
Water Treatment Study	75,000	—	3,137	71,863
	\$119,438,094	\$86,512,404	\$14,259,973	\$18,665,717
Carbonate Trend				
Buffalo Creek				
— Union Oil	\$21,985,000	\$ 7,405,017	\$ 4,812,576	\$ 9,767,407
Heavy Oil				
Petro-Canada	\$ 9,458,046	\$ 7,226,788	\$ 1,577,690	\$ 653,568
A.E.C.	4,975,000	2,806,328	1,617,001	551,671
Pengalta	188,000	17,987	102,475	67,538
	\$14,621,046	\$10,051,103	\$ 3,297,166	\$ 1,272,777
Enhanced Recovery				
P.R.I.	\$ 625,000	\$ 35,557	\$ 304,915	\$ 284,528
McCallum, Stewart & Associates	25,000	—	23,246	1,754
	\$ 650,000	\$ 35,557	\$ 328,161	\$ 286,282
Bitumen Upgrading				
Flexicoking — Exxon	\$ 500,000	\$ 353,829	\$ —	\$ 146,171
Hydrocracking — E.M.R.	214,520	214,520	—	—
Hydrotreating — UOP	176,183	176,183	—	—
— Catalytic Inc.	206,640	144,685	53,747	8,208
Petrochemicals — Mitsubishi	679,500	673,000	2,853	3,647
Heavy Oil Upgrading Study	1,810,000	65,158	494,281	1,250,561
Eureka Process	415,125	—	16,318	398,807
Fluid Bed Combustion Test	12,500	—	3,026	9,474
California Synfuels	14,760	—	12,757	2,003
REM Feasibility Study	125,000	—	86,414	38,586
McKinsey & Associates Study	75,000	—	33,000	42,000
	\$ 4,229,228	\$ 1,627,375	\$ 702,396	\$ 1,899,457
Technology Handling				
Data Base Administration	\$ 726,595	\$ 435,916	\$ 333,810	\$ (43,131)
Technical Reports	91,865	91,865	—	—
Patent Costs	500,000	144,807	52,277	302,916
	\$ 1,318,460	\$ 672,588	\$ 386,087	\$ 259,785
Training Activities	\$ 535,000	\$ 200,439	\$ 207,109	\$ 127,452
International Activities	\$ 729,500	\$ 177,005	\$ 244,408	\$ 308,087
Totals	<u>\$201,499,444</u>	<u>\$129,349,519</u>	<u>\$33,358,911</u>	<u>\$38,791,014</u>

TABLE 3
Statement of Revenue
Expenditure & Fund Balance

Oil Sands Technology and Research Fund
Six-Year Summary
For the years ended March 31

	1982	1981	1980	1979	1978	1977 and Prior	Total
Revenue							
Alberta Heritage Savings Trust Fund	\$28 500 000	\$28 000 000	\$38 000 000	\$33 161 289	\$20 290 523	\$ 9 497 220	\$157 449 032
Technology sales	3 477 561	2 362 893	282 312	407 623	3 000	12 027	6 545 416
	<u>\$31 977 561</u>	<u>\$30 362 893</u>	<u>\$38 282 312</u>	<u>\$33 568 912</u>	<u>\$20 293 523</u>	<u>\$ 9 509 247</u>	<u>\$163 994 448</u>
Expenditures							
Institutional Research							
Alberta Research Council Information Centre	\$ 394 205	\$ 313 017	\$ 200 000	\$ 200 000	\$ 200 000	\$ 400 000	\$ 1 707 222
Oil Sands Research Centre	2 869 308	2 508 783	1 336 003	1 294 191	923 636	2 800 000	11 731 921
Sample Bank	240 975	218 361	65 763	22 064	59 000		606 163
Geological Program	469 740	353 953	67 842				891 535
University Contracts	2 103 367	1 975 243	1 291 193	880 585	634 341	731 923	7 616 652
Professorships	472 084	353 813	167 730	160 000	147 500	55 000	1 356 127
Scholarships and Fellowships	201 760	85 131	121 541	107 530	136 516	49 920	702 398
Ontario Research Foundation	1 622	4 477					6 099
University Access Program	44 159	26 882					71 041
	<u>\$ 6 797 220</u>	<u>\$ 5 839 660</u>	<u>\$ 3 250 072</u>	<u>\$ 2 664 370</u>	<u>\$ 2 100 993</u>	<u>\$ 4 036 843</u>	<u>\$ 24 689 158</u>
Mining and Extraction							
Retorting							
Umatia	\$ 1 348 402	\$ 812 790	\$ 653 734	\$ 528 210	\$ 1 103 479		\$ 4 446 615
Lurgi		239 075	319 870			62 220	621 165
Tailings Treatment							
Xana	617 160	333 242	223 455	170 594	15 047		1 359 498
EcoPlastics		16 829	16 598	26 490			59 917
Tunneling			17 970	39 823	32 732	86 865	177 390
Dredging			16 760	10 898			27 658
Solvent Study			26 343				26 343
Oil Sands Demonstration Centre	18 253	23 069					41 322
Kruyer Research	240 000						240 000
R.T.R. Project	100 000						100 000
	<u>\$ 2 323 815</u>	<u>\$ 1 425 005</u>	<u>\$ 1 274 730</u>	<u>\$ 776 015</u>	<u>\$ 1 151 258</u>	<u>\$ 149 085</u>	<u>\$ 7 099 908</u>
In Situ Oil Sands							
Peace River Shall	\$ 7 413 067	\$ 6 510 798	\$22 074 583	\$18 204 757	\$ 2 547 441		\$ 56 750 646
Athabasca							
Amoco	1 865 234	4 241 687	3 086 470	3 298 545	6 983 208	5 096 570	24 571 714
Nymac Gulf	36	20 846	129 684	140 662	1 200 000		1 449 464
Hudson's Bay Gulf	1 461 788	3 101 732	366 965				4 930 485
Cold Lake B.P.	3 231 266	991 585	948 474	1 645 018	4 492 932	1 217 941	12 527 216
Consultants			6 630	23 970			30 600
Gemina	123 544	99 487					223 031
Walden	9 346	87 268					96 614
Minenco	35 000						35 000
Waterloo Centre	111 333						111 333
Electrical Heating Study	6 294						6 294
Water Treatment Study	3 137						3 137
	<u>\$14 259 973</u>	<u>\$15 014 910</u>	<u>\$26 646 178</u>	<u>\$23 313 224</u>	<u>\$15 223 581</u>	<u>\$ 6 314 511</u>	<u>\$100 772 377</u>

TABLE 3 CONT'D.

	1982	1981	1980	1979	1978	1977 and Prior	Total
Carbonate Trend							
Buffalo Creek							
Union Oil	\$ 4 812 576	\$ 2 111 852	\$ 1 993 570	\$ 3 299 595	\$	\$	\$ 12 217 591
Heavy Oil							
Petro Canada	\$ 1 577 690	\$ 1 135 972	\$ 4 834 786	\$ 1 256 030	\$	\$	\$ 8 804 478
A E C	1 617 001	2 747 632	58 696				4 423 429
Pengalta	102 475	417	17 570				120 462
	\$ 3 297 166	\$ 3 884 021	\$ 4 911 052	\$ 1 256 030	\$	\$	\$ 13 348 269
Enhanced Recovery							
PRI	\$ 304 915	\$ 20 669	\$ 14 888	\$	\$	\$	\$ 340 472
McCallum, Stewart & Associates	23 246						23 246
	\$ 328 161	\$ 20 669	\$ 14 888	\$	\$	\$	\$ 363 718
Bitumen Upgrading							
Flexcoking Exxon	\$	\$	\$	\$	\$	\$ 253 829	\$ 253 829
Hydrocracking E M R						214 520	214 520
Hydrotreating UOP			88 785	87 398			176 183
Catalytic Inc	53 747	144 685					198 432
Petrochemicals							
Mitsubishi	2 853	2 877	265 855	359 194	45 074		675 853
Heavy Oil Upgrading Study	494 281	65 158					559 439
Eureka Process	16 318						16 318
Fluid Bed Combustion Study	3 026						3 026
California Synfuels	12 757						12 757
REM Feasibility Study	86 414						86 414
McKinsey & Associates Study	33 000						33 000
	\$ 702 396	\$ 212 720	\$ 354 640	\$ 446 592	\$ 45 074	\$ 568 349	\$ 2 329 771
Technology Handling							
Data Base							
Administration	\$ 333 810	\$ 116 073	\$ 198 691	\$ 121 152	\$	\$	\$ 769 726
Technical Reports		91 865					91 865
Patent Costs	52 277	66 184	78 623				197 084
	\$ 386 087	\$ 274 122	\$ 77 314	\$ 121 152	\$	\$	\$ 1 058 675
Training Activities	\$ 207 109	\$ 200 439	\$	\$	\$	\$	\$ 407 548
International Activities	\$ 244 408	\$ 177 005	\$	\$	\$	\$	\$ 421 413
	\$33 358 911	\$29 160 403	\$38 722 444	\$31 876 978	\$18 520 906	\$11 068 788	\$162 708 430
Excess of revenue over Expenditures	\$ (1 381 350)	\$ 1 202 490	\$ (440 132)	\$ 1 691 934	\$ 1 772 617	\$ (1 559 541)	\$ 1 286 018
Fund balance at beginning of period	2 667 368	1 464 878	1 905 010	213 076	(1 559 541)		
Fund balance at end of period	\$ 1 286 018	\$ 2 667 368	\$ 1 464 878	\$ 1 905 010	\$ 213 076	\$ (1 559 541)	\$ 1 286 018

AUDITOR'S REPORT AND FINANCIAL STATEMENTS

**Alberta Oil Sands Technology and Research Authority
Oil Sands Technology and Research Fund
Financial Statements
March 31, 1982**

Auditor's Report
Balance Sheet
Statement of Revenue, Expenditure and Fund Balance
Notes to the Financial Statements



ALBERTA LEGISLATURE

OFFICE OF THE AUDITOR GENERAL

AUDITOR'S REPORT

To the Members of the Alberta Oil
Sands Technology and Research Authority

I have examined the balance sheet of the Alberta Oil Sands Technology and Research Authority — Oil Sands Technology and Research Fund as at March 31, 1982 and the statement of revenue, expenditure and fund balance for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances.

In my opinion, these financial statements present fairly the financial position of the Fund as at March 31, 1982 and the results of its operations for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Edmonton, Alberta
June 22, 1982


C.A.
Auditor General

**ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY
OIL SANDS TECHNOLOGY AND RESEARCH FUND**

BALANCE SHEET

AS AT MARCH 31, 1982

	1982	1981
ASSETS		
Current:		
Cash	\$4,344,103	\$3,734,982
Deposits in trust (Note 3)	279,801	163,549
Deposits on projects, net (Note 4)	936,338	1,806,690
Accounts Receivable	1,495,222	1,046,454
Prepaid expense	5,740	2,722
Due from the Province	—	\$2,000,000
	<u>\$7,061,204</u>	<u>\$8,754,397</u>
LIABILITIES		
Current:		
Accounts Payable	\$5,492,775	\$5,923,480
Holdbacks payable	279,801	163,549
Deferred Credits	2,610	
	5,775,186	6,087,029
Fund Balance, Statement B	1,286,018	2,667,368
	<u>\$7,061,204</u>	<u>\$8,754,397</u>

The accompanying notes are part of these financial statements.

ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY
OIL SANDS TECHNOLOGY AND RESEARCH FUND

STATEMENT OF REVENUE, EXPENDITURE AND FUND BALANCE

FOR THE YEAR ENDED MARCH 31, 1982

	1982	1981
Revenue:		
Contributions by the Province of Alberta:		
Alberta Heritage Savings Trust Fund (Note 6)	\$28,500,000	\$28,000,000
Technology Sales	3,477,561	2,362,893
	<u>31,977,561</u>	<u>30,362,893</u>
Expenditure:		
In situ oil sands	14,259,973	15,014,910
Institutional research	6,797,220	5,839,660
Carbonate trend	4,812,576	2,111,852
Heavy Oil	3,297,166	3,884,021
Mining and extraction	2,323,815	1,425,005
Bitumen upgrading	702,396	212,720
Technology handling	386,087	274,122
Enhanced recovery	328,161	20,669
International activities	244,408	177,005
Training activities	207,109	200,439
	<u>33,358,911</u>	<u>29,160,403</u>
Excess of revenue over expenditure for the year	(1,381,350)	1,202,490
Fund balance at beginning of year	2,667,368	1,464,878
Fund balance at end of year	<u>\$ 1,286,018</u>	<u>\$ 2,667,368</u>

**ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY
OIL SANDS TECHNOLOGY AND RESEARCH FUND**

NOTES TO THE FINANCIAL STATEMENTS

MARCH 31, 1982

Note 1 Authority

The Alberta Oil Sands Technology and Research Authority operates under the authority of The Oil Sands Technology and Research Authority Act, Chapter 49, Statutes of Alberta 1974.

Note 2 Significant Accounting Policies

The statements present Fund transactions only, therefore, those costs charged to the General Revenue Fund are not shown on the balance sheet or on the statement of revenue, expenditure and fund balance but are disclosed in Note 7.

Expenditures from the Fund are not capitalized due to the intangible nature of assets that may accrue to the Authority. The Authority will be entitled to share in any assets remaining at the end of a project in proportion to its percentage of participation.

A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Deposits in Trust

Deposits in trust consist of deposits in the General Trust Fund of the Province of Alberta.

Note 4 Deposits on Projects

The amount of \$936,338 (1981 \$1,806,690) shown on the balance sheet represents the net excess of cash calls on projects over actual expenditures.

Note 5 Advances from the Province of Alberta

The Oil Sands Technology and Research Authority Act provides for advances from the General Revenue Fund of the Province of Alberta not to exceed \$100,000,000. At March 31, 1982 such advances aggregated SNIL (1981 SNIL).

Note 6 Contributions by the Province of Alberta

The Appropriation (Alberta Heritage Savings Trust Fund, Capital Projects Division) Act, 1979 provided for payments to the Authority to a maximum of \$61,000,000 for the year ended March 31, 1982 (1981 \$46,000,000). Amounts actually received from this source totalled \$28,500,000 (1981 \$28,000,000). The provision which enables the Authority to receive funds up to the stated maximum lapses at the end of the fiscal year.

Note 7 Administration Costs

Administration Costs of the Authority, provided for by Section 13 of the Act, are paid by the Province from funds appropriated for that purpose and are summarized as follows:

	1982	1981
Salaries and wages	\$1,030,349	\$ 817,010
Fees and commissions	387,865	252,032
Rental of property and equipment	253,727	256,153
Travelling and entertainment	198,971	184,554
Employee Benefits	137,441	197,462
Furniture and equipment purchases	30,302	19,333
Materials and supplies	27,279	28,894
Advertising	21,368	18,629
Unitar conference	19,607	
Contracts for construction	15,896	8,487
Freight, express and postage	15,691	10,460
Staff relocation costs	15,338	21,117
Grants	13,600	
Telephone and Telegraph	11,085	11,455
Equipment maintenance	7,499	2,422
	\$2,186,018	\$1,828,008

Furniture and equipment purchases are included in administration costs. Cumulative costs to March 31, 1982 of \$126,715 (1981 \$96,413) have not been reflected on the balance sheet inasmuch as they are not part of the Oil Sands Technology and Research Fund.

Note 8 Commitments

In addition to the total expenditure shown on Statement B, the Authority had outstanding commitments as at March 31, 1982 totalling \$38,791,013 (1981 \$47,608,636) for approved projects.

Note 9 Approval of Financial Statements

These financial statements were approved by management on June 22, 1982.